Stepping N-to the Past

Plant Responses to Anthropogenic Nitrogen Deposition

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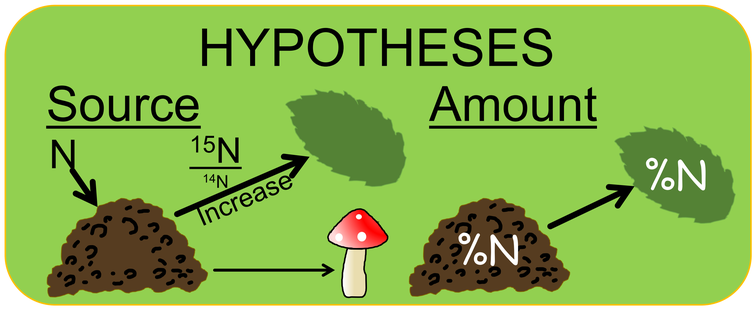
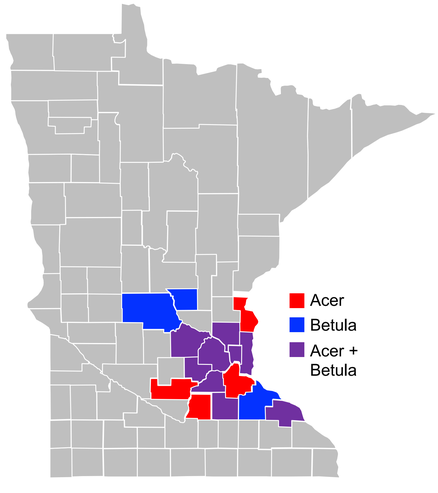
Introduction

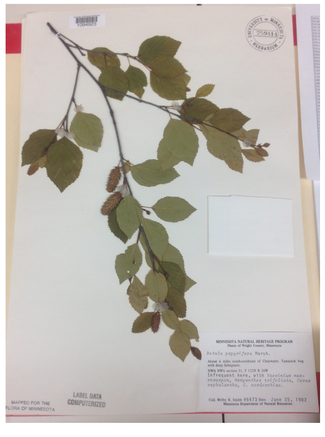
- Human activity has doubled the amount of nitrogen (N) deposited from the air in the last century.[1]
- Leaf N increased substantially in moist forests in Panama following over at century of N deposition (9 kg N $ha^{-1}y^{-1}$).[2,3]
- Historical effect of N deposition on plant N uptake has not been quantified in Minnesota, where the N deposition rate is lower (4.8 kg N $ha^{-1}y^{-1}$), and representative of much of eastern U.S.[4]



Methods

- Sampled long-term leaf tissue samples from the Bell Museum of Natural History (years 1890 – 2001) from genera *Acer* and *Betula.*
- Species sampled: *Acer saccharum*, *Acer saccharrinum*, *Acer negundo*, *Betula papyrifera*, *Betula pumila*, and *Betula alleghaniensis.*
- Analyzed ^{15}N:^{14}N isotopic composition ($\delta^{15}N$) and leaf N content (%N) using an Elemental Analyzer with Isotope-Ratio Mass Spectrometry (EA-IRMS).
- Fit linear regression models to quantify isotopic and elemental leaf trends through time.

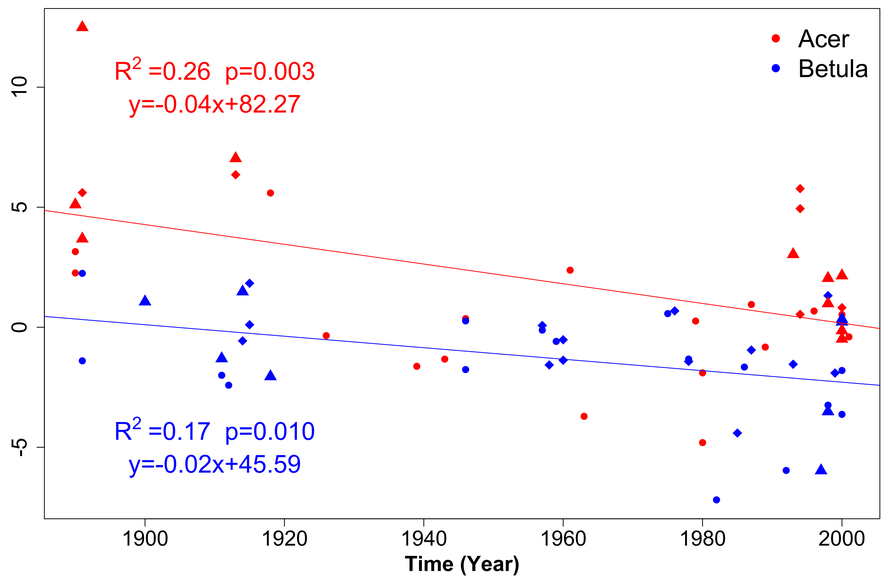




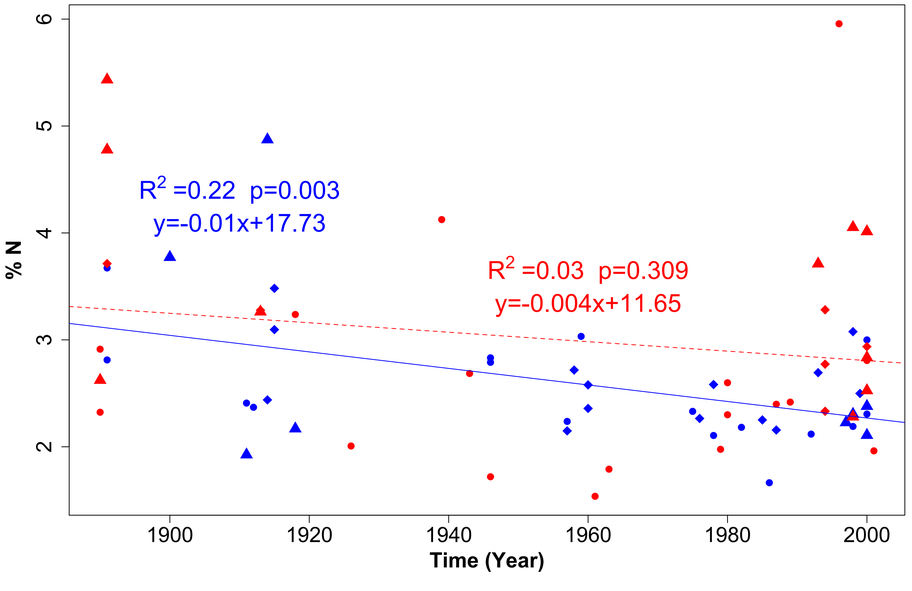
Results

- $\delta^{15}N$ and %N decreased over time, contrary to expectations.
- For $\delta^{15}N$, both Acer and Betula decreased over time
- For %N, only the decrease seen in Betula was significant

$\delta^{15}N$ of Acer and Betula Over Time

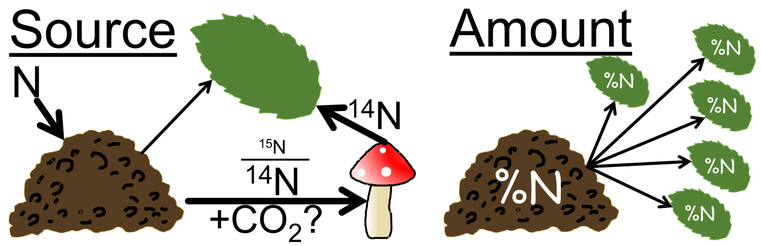


%N of Acer and Betula Over Time



Conclusions

- Anthropogenic N deposition may not be the only factor to influence soil N availability over the last century.
- Similar historical declines in $\delta^{15}N$ and %N in Kansas grasslands (N deposition rate similar to MN) suggested elevated CO_2 limited soil N availability in the 20th century.[5]



Future Directions

- To test for evidence of the importance of elevated CO_2 from fossil fuel combustion, analyze leaf $\delta^{13}C$. We expect that leaf $\delta^{13}C$ will increase through time (also known as the Suess effect).[6]
- Sample fungi for C/N isotopes. Since fungi are N trading partners with plants, N-limited plants may increase reliance on fungi
- Analyze $\delta^{15}N$ and %N in plant collections across an N deposition gradient

References

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